GUIDELINES FOR TRAINING AND TESTING A DESCRIPTIVE MEAT PANEL

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Running Head: Guidelines for Panel Training

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Abstract

GUIDELINES FOR TRAINING AND TESTING A DESCRIPTIVE MEAT PANEL. H. R. Cross, R. Moen and M. S. Stanfield. J. Food Science.

Step by step procedures for interviewing, screening, training and testing a descriptive meat panel were developed. The parameters evaluated were tenderness, juiciness and amount of detectable connective tissue. The suitability of the proposed method was evaluated with four panels in four different research stations. Common samples were used for training and testing. All procedures, including cooking and sample preparation were standardized among the four research stations. The results of the trained descriptive panels from the four stations were highly correlated for tenderness and connective tissue. The range in juiciness was small making it difficult for any panel to detect differences.

Introduction

Systemic analysis of the sensory properties of foods involves the use of human subjects as analytical instruments in a laboratory environment (Amerine et al., 1965; Prell, 1976). Foods are usually submitted to analytical panels to provide information that can lead to product improvement, quality maintenance or new product development. Although the fate of a food product always rests on its acceptance by the consumer, much of the initial testing is through the use of analytical panels.

There are many types of analytical panels. Amerine et al. (1965), Abbott (1973) and Prell (1976), have excellent reviews and discussions on the different types of analytical panels. There is some confusion in the literature as to the degree of "training" of an analytical panel. Most of the data reported by meat scientists is from "trained" descriptive panels. Descriptive panels are defined by Prell (1976) as test methods that measure qualitative and/or quantitative characteristics among samples. An example of a descriptive test might be an 8-point structured scale on tenderness with 8 = extremely tender and 1 = extremely tough. Many scientists make the mistake of using hedonic terms such as like/dislike with a trained panel. Hedonic tests are only for large, randomly selected, untrained target consumer panels (Prell, 1976).

There are few ground rules as to what represents a "trained" panel. In some instances, training may be no more than an introduction to the scoring methods and procedures, while in

other cases it may be a 3-4 month extensively trained "expert" panel. It is difficult to compare panel results between stations unless some common guidelines have been followed in training and conducting the panel. It is obvious that correct sensory procedures can greatly improve the reliability and validity of sensory results within and between stations.

In the absence of an objective instrumental measurement, a trained descriptive sensory panel must be used to provide measurements of food quality characteristics. How reliable are these measurements? Do we have a "human analytical instrument" for which valid inferences can be made concerning the quality of various food product characteristics? These questions must be answered before a research study on food quality can be conducted.

The purpose of this investigation was to provide a technique for selection, training, and evaluation of a descriptive panel which was used for identifying meat textural properties. The technique is general enough to have applications in other food areas as well.

Evaluation of the technique will be by an experimental design on a meat descriptive panel trained by the technique. The experiment is designed to identify the factors that might influence measurements from this panel and whether their measurements correlate with three separately trained meat descriptive panels also instructed by the same technique.

Experimental

Techniques for selection, training and evaluating panel performance of a descriptive meat panel were developed. These techniques were developed on one panel at research station number one (USDA). The same techniques were applied to three additional panels at three different research stations (number two through three) in order to validate the techniques. These procedures will be detailed under the appropriate section.

Cooking method: Steaks (2.54 cm thick) were broiled to varying degrees of doneness on a Farberware grill (Model 450).[3] Degree of doneness was manipulated by cooking to different internal temperatures. Internal temperature was monitored with Iron/constantan thermocouples (36 gauge-teflon coated) and a Brown recorder. Steaks were thawed prior to cooking for 24 hr. in a 4-5°C refrigerator.

Panel source: Potential panelists were selected from individuals ranging in age from 20 to 60. Reports on the influence of age on acuity of sensory preception have been contradictory (Boggs and Hanson, 1949). We agree with Bengtsson and Helm (1946) and Amerine et al. (1965) that the criterion of selection should be ability, not the age of the individual judge. In order to properly evaluate the methods proposed in this study, only potential panelists with no prior experience were selected.

Description of technique: The technique for selection, training and testing a meat descriptive panel is given as a 4-step procedure as outlined in figure 1.

Step 1: Personal interview: This first step is likely the most important. Each potential panelist is individually interviewed to establish their interest, availability, personality traits and health. The general nature of the study for which they are being trained is discussed. Interest and availability are of prime importance in choosing a potential panelist.

The interaction between the candidate and the interviewer provides maximum information about what is expected of a prospective panel member, what the candidate can expect from the sensory program and what the sensory program provides to the organization.

The information gathered in the personal interview provides the basis for:

a. Disqualifying those candidates who are neither interested nor available.

b. Classifying the qualified candidates as potentials for general routine tests and for special test situations.

c. Selecting those panelists to be screened and trained in descriptive analysis.

Step 2: Screening: The screening guidelines should focus on those parameters to be measured within the respective sensory problem. Triangle tests are recommended for the screening process. Since the size of the group being tested affects the efficiency of the ultimate panel, a large number of candidates is included (at least twice as many as needed on panel). A sequential analysis procedure is used to reduce the testing needed (Bradley, 1953).

The advantage in this procedure is that a decision on very good or very poor candidates can be made after a small number of triangle tests. Consequently, these candidates are dropped from the screening process thereby reducing the total number of triangle tests needed.

The sequential procedure makes one of the following decisions after each triangle test; (1) accept the candidate as a potential panelist; (2) reject him; or (3) continue testing. The decisions are based on specifications of four parameters.

P_0 = maximum proportion of correct decisions ruled as an unacceptable candidate.

P_1 = minimum proportion of correct decisions ruled as an acceptable candidate.

a = probability of selecting an unacceptable candidate.

b = probability of rejecting an acceptable candidate.

Since the expected proportion of correct decisions by chance is .33, Po must be chosen greater than .33. P_1 must exceed Po. a and b represent the risks of making incorrect decisions for selecting or rejecting candidates.

By plotting test numbers against the accumulated number of correct test results, a decision is made based on the region in which the point is plotted (figure 2). The region boundaries are given by:

$$Y = mx + h$$

$$Y = mx = h'$$

where $m = \log_e \left(\frac{1-Po}{1-P_1}\right) \Big/ \left(\log_e \frac{P_1}{Po} - \log_e \frac{1-P_1}{1-Po}\right)$

$h = \log_e \frac{b}{1-a} \Big/ \left(\log_e \frac{P_1}{Po} - \log_e \frac{1-P_1}{1-Po}\right)$

$h' - \log_e \frac{1-b}{a} \Big/ \left(\log_e \frac{P_1}{Po} - \log_e \frac{1-P_1}{1-Po}\right)$

Test samples for triangle tests were prepared so that a two unit different (i.e. 5 versus 7 rating on 8 point rating scale) in the attribute being tested is observed. In this study the attributes tested were tenderness, juiciness and connective tissue amount. Differences were sifficient so that they could be easily detected by an expert. The values $P_0 = .45$, $P_1 = .70$, $a = .10$, and $b = .10$ were used. The graph in figure 2 was used to screen panelists. Sample placement and attributes evaluated on any given session were randomly selected for each triangle test.

At the end of the screening period the candidates in the "accept" and "continue testing" region were selected for training. Since time was a factor, screening was stopped after 15 sessions. It would be desirable to select for training only those in the "accept" region but in this particular instance the majority of the candidates were in the "continue testing" region. The screening" segment of the panel selection should not be considered a part of training but rather a test to quickly eliminate those individuals who cannot detect large attribute differences.

Step 3: Training: 1. General Requirements: Panelists are trained to a) familiarize an individual with test procedures; (b) improve an individual's ability to recognize and identify sensory attributes; and (c) improve an individual's sensitivity and memory permitting more precise and consistent sensory judgements.

To ensure cooperation and motivation, panelists should understand the importance of the study. Let them know that you are pleased to have them participate and their cooperation is appreciated. Without influencing the panelists' future responses, give them as much specific information as possible on the purpose of the test.

The importance of concentration was stressed. To increase the tester's ability to concentrate, the test area was appropriately lighted, free from odors, temperature controlled, quiet and free from distractions. Comfortable seating was provided (ASTM, 1968).

Test participants were instructed to avoid consuming strong taste sensations and contact with strong odorous materials at least 30 minutes prior to an evaluation. Panelists were asked to avoid the use of perfumed cosmetics and locations and to remove lipstick before testing. Panelists who were ill or who were suffering from a cold or nasal congestion were not used. Panelists were instructed on the sensory techniques to be used. They understand the methods, scales, score sheets and terminology to be used in a test. The amount of sample a judge put in his mouth was standardized (two 1.27 x 1.27 x 1.90 cm sections per sample). The panelist was instructed to swallow each sample if possible.

Rinsing was standardized. Each panel member rinsed between samples. Room temperature spring water was provided.

The interval between samples was standardized. Approximately two to three minutes was allowed for each sample. Enough time should be allowed between samples to permit recovery from flavor build-up, yet not so much that the taster loses his ability to discriminate.

2. Training: Training was accomplished through individual and group sessions in which various samples of the product types usually involved in the tests were evaluated and discussed. For example, steaks from animals of varying ages (9 months to more than 10 year) were used to demonstrate differences in connective tissue. Thaw-rigor muscle from young animals were used to demonstrate tough muscle low in connective tissue. Steaks cooked to "rare" (60°C) or "well-done" (80°C) degrees of doneness provided ranges in juiciness.

During the early stages of training, the panel leader should strive to identify the extremes and middle of the rating scale (table 1). During training it was necessary to refer back to some "standards" i.e., the psoas major muscle for extremely tender and old cow longissimus for extremely tough samples. As training progressed the panelists were able to identify other points along the rating scale.

Individual panelist discussion was encouraged to bring to light any misunderstandings that might not otherwise be evident. When problems developed with one or more particular attribute, additional samples were prepared to demonstrate various levels of that attribute. Each training session served to demonstrate

the range of quality of a single attribute. For example, the objective of one particular session might be to demonstrate three levels of tenderness on the 8 point scale. Enough sample was available for panelists to repeat their evaluations a number of times.

An average of three training sessions were held each week. Each session lasted from one to one and a half hours. After ten to twelve training sessions the panel was "evaluated." The "performance evaluation" identified specific problem areas for individual panelists. In many cases the "evaluation" confirmed the panel leader's suspicions. Additional training sessions were held concentrating on the problem areas identified by the "evaluation." After two to three weeks of additional training another "evaluation" was conducted. The "evaluations" assisted the panel leader in evaluating the results of training.

Step 4: Performance Evaluation: Evaluation can begin soon after training is initiated. The initial and subsequent evaluations will assist the panel leader in identifying problems among individual panelists. Nine samples, S_1, S_2-----S_9 were selected to cover the full range of the attribute being trained for (tenderness, juiciness and connective tissue). Panel evaluation was spread over 4 days with 3 sessions per day and 3 samples per session. The design is outlined in table 2.

Data analysis was to treat the data for each candidate as a one-way analysis of variance with nine treatments and four

observations per cell. The design could be treated as a balanced-lattice design (Cochran and Cox, 1957) so that day and effects can be studied. The data layout is given in table 3. From the ANOVA table, the F-ratio defined as F = MS treatments/MS error was calculated. Used in this context the F=ratio is a measure of a panelists' ability to award different scores to different samples while being able to repeat himself on the same sample a day (or more) later. The degree to which a person discriminates between samples and is consistent in his replicate judgments will be reflected in his F-ratio (ASTM, 1968). The larger the F-ratio, the better the panelist. Candidates can be ranked on the basis of these F-ratios.

The number of panelists selected should be based on the test results. Including a person with less than satisfactory results just to achieve a predetermined panel size is wrong. ASTM (1968) requires a minimum of 5 panelists since fewer would represent too much dependence upon any one individual's response. In this study a minimum panel size of 8 was selected.

The four day test was carried out with nine samples prepared to have a wide range in tenderness, juiciness and connective tissue. Results of a test for the eleven panelists and panel leader are presented in table 4. The panel leader or expert had no prior knowledge of the samples being evaluated. Comparisons of the F-ratios should be made between the panel leader and the individual panelists. It is not unusual for an

individual panelist to have a higher F-ratio than the panel leader. The F-ratio is an indication of the panelists ability to discriminate while also repeating his evaluation of duplicate samples.

Since more than one palatability attribute was involved, a table of ranks of the F-ratios is presented in table 5. The F-ratiosin table 4 and the ranks in table 5 serve as a tool to help the panel leader make training decisions. For example, panelist number eight was having a problem with connective tissue while panelist number one was having difficulties with tenderness and juiciness.

A single evaluation as outlined in tables 4 and 5 is not conclusive. The tests alone will not make the decision of who should or should not be on the panel. Subsequent tests were useful to evaluate the panelist's performance throughout the study. Training for this panel lasted four months. The panel was tested four times. Panelist number one was consistently rated last and was ultimately dropped from the panel.

Validation of Technique-Design: A technique for training a meat descriptive panel has been described. In order to test or validate the technique the following questions must be answered: (a) does the panel selected by the technique provide a quantitative measurement for tenderness, juiciness and connective tissue; (b) what factors may influence the measurements of the panel; and (c) will the descriptive panel (panel no. 1) correlate with three other (panels 2 to 4)?

A balanced incomplete block design was conducted on the meat descriptive panel approximately four months after training was completed. Longissimus steaks from beef short-loins were selected from eleven maturity/marbling cells (treatments). Marbling ranged from moderately abundant to practically devoid and maturity from A minus to E plus (table 6). Steaks were cooked on Farberware grills to an internal temperature of 70°C. Five (maturity/marbling cell) of the total eleven treatments were assigned to each session (block) with eleven sessions needed to obtain five replications of each treatment. The design is given in table 7. Treatment order within a session was randomly assigned to each panelist. Each panelist was instructed to rate each sample for tenderness, juiciness, and connective tissue.

Analysis involved testing each of the 10 panelists (panel no. 1) for a session and treatment effect. The panelists' data were combined to test for a panel/treatment interaction.

Three additional panels were trained at three different universities using the same techniques described in this manuscript. The duration of training was approximately the same. Procedures were standardized as much as possible among all panels. Common samples were used to evaluate all four panels during training. All equipment for cooking and temperature measurement was identical among the four panels. All panels sampled steaks from shortloins described in tables 6 and 7. Correlation coefficients were calculated between all panels.

Results and Discussion

Analysis of variance results for panel number one for the balanced incomplete block design are presented in table 8. There were highly significant differences in treatments for tenderness and connective tissue. None of the panelists detected differences in treatments for juiciness. There was no appearent session effect for any panelist. This indicates that the panelists' rated the sample consistently from session to session. This is an important panel characteristic if we are to have a "human analytical instrument."

Panelists' data were combined as a two-way analysis of variance with treatments fixed and panelists random (table 9). There was no panelist by treatment interaction indicating that individual panelists agreed with one another in their ranking of the treatments. Therefore, panelists' scores may be averaged even though there was significant variability in the means of panelists.

An estimate of measurement error can be obtained by pooling the sums of squares of panelist by treatment interactions with the experimental error. The resulting standard deviations for individual panelists and the average of panelists are given in table 10. The standard deviations are measurements of the precision of our "human analytical instrument." Results show that the average rating for the panelists can repeat within a one-unit rating point for all three attributes.

Correlation coefficients (using averages) of the meat descriptive panel (panel 1) with the other three panels (panel 2, panel 3, panel 4) are presented in table 11. Correlations with the other panels were high for tenderness and connective tissue but low for juiciness. Juiciness correlations were low because of the small range of juiciness in the eleven treatments. The range for juiciness was 3.1, where for tenderness and connective tissue it was 5.9 and 5.4, respectively.

The panel measurement for juiciness was not sensitive enough to pick up such a small range. This is important to identify before the actual study begins. If a range is exhibited as limited in this study, misleading results concerning juiciness could result.

Conclusions

A 4-step technique for developing a trained descriptive panel has been presented. The technique is relatively simple to use and the test results can be computed using a hand calculator. More sophisticated experimental designs are useful to identify factors that might affect a panel measurement. They provide a useful tool in better understanding this type of measurement system.

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[3]Mention of brand names does not imply endorsement by the U.S. Government.

Fig. 1. Steps in selecting and training a descriptive meat panel.

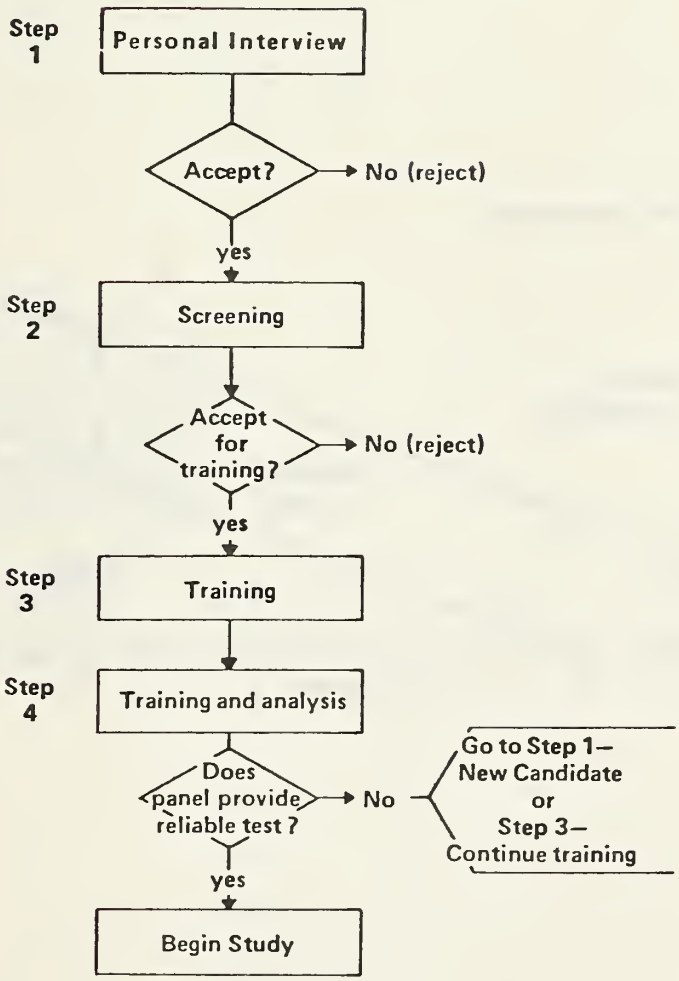

Fig. 2. Screening.

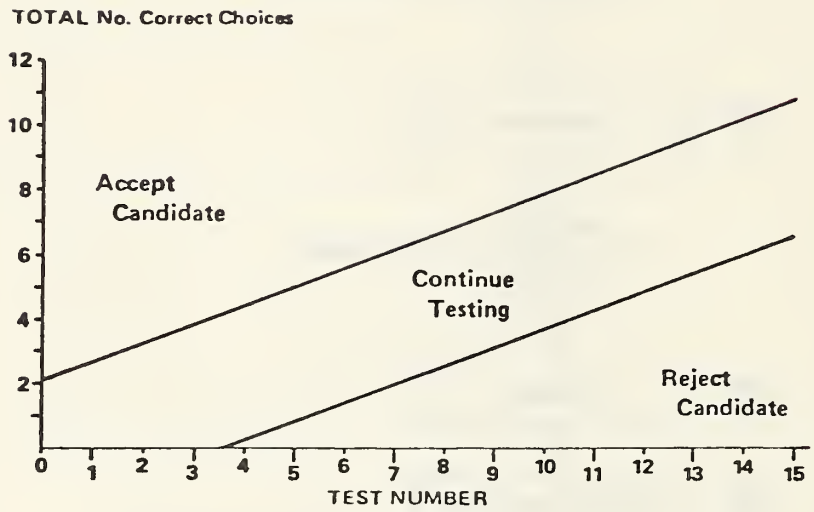

Table 1. Sensory Attributes.

Tenderness	Juiciness	Connective tissue
8 - Extremely tender	8 - Extremely juicy	8 - None
7 - Very tender	7 - Very juicy	7 - Practically none
6 - Moderately tender	6 - Moderately juicy	6 - Traces
5 - Slightly tender	5 - Slightly juicy	5 - Slight
4 - Slightly tough	4 - Slightly dry	4 - Moderate
3 - Moderately tough	3 - Moderately dry	3 - Slightly abundant
2 - Very tough	2 - Very dry	2 - Moderately abundant
1 - Extremely tough	1 - Extremely dry	1 - Abundant

Table 2. Design layout for panel test.

DAY 1			DAY 2			DAY 3			DAY 4		
Session			Session			Session			Session		
1	2	3	1	2	3	1	2	3	1	2	3
T_1[a]	T_4	T_7	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3
T_2	T_5	T_8	T_4	T_5	T_6	T_5	T_6	T_4	T_6	T_4	T_5
T_3	T_6	T_9	T_7	T_8	T_9	T_9	T_7	T_8	T_8	T_9	T_7

[a] T_1 = Sample number one.

Table 3. One-way ANOVA data layout.

Sample Number								
1	2	3	4	5	6	7	8	9
X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	X_{18}	X_{19}
X_{21}	X_{22}							
X_{31}	X_{32}							
X_{41}	X_{41}	X_{43}	X_{44}	X_{45}	X_{46}	X_{47}	X_{48}	X_{49}

Table 4. Sample test. F-ratios by palatability attribute.

Attribute	Panel Leader	F-Ratios Panelist Number										
		1	2	3	4	5	6	7	8	9	10	11
Tenderness	14.40	2.76	7.12	7.54	8.29	8.87	8.67	6.12	5.37	6.77	8.78	3.64
Juiciness	5.33	2.37	3.59	8.03	3.58	8.78	6.94	6.14	4.59	1.89	7.50	3.18
Connective tissue	8.78	4.02	4.39	4.07	5.37	5.32	8.32	3.76	0.95	6.84	12.32	4.03

Table 5. Sample Test. Ranks of panelist based on F-ratios.

Attribute	Panel Leader	Ranking Panelist Number 1	2	3	4	5	6	7	8	9	10	11
Tenderness	1	12	7	6	5	2	4	9	10	8	3	[illegible]
Juiciness	6	11	8	2	9	1	4	5	7	12	3	10
Connective tissue	2	10	7	8	5	6	3	11	12	4	1	9
Sum	9	33	21	16	19	9	11	25	29	24	7	30
Overall rank	2	12	67	5	6	2	4	9	10	8	1	11

Table 6. Selection design for beef shortloins.

Marbling Amount	Maturity Rating A	B	C	E
Moderately Abundant Slightly Abundant Moderate	Cell No. 1 n = 5	Cell No. 2 n = 5	Cell No. 3 n = 5	Cell No. 4 n = 5
Modest Small Slight	Cell No. 5 n = 5	Cell No. 6 n = 5	Cell No. 7 n = 5	
Traces Prac. Devoid	Cell No. 8 n = 5	Cell No. 9 n = 5	Cell No. 10 n = 5	Cell No. 11 n = 5

Table 7. Panel design.

DAY 1		DAY 2		DAY 3		DAY 4		DAY 5		DAY 6
Session		Session		Session		Session		Session		Session
1	2	1	2	1	2	1	2	1	2	1
T_2[a]	T_1	T_1	T_4	T_2	T_2	T_1	T_1	T_3	T_1	T_3
T_3	T_5	T_4	T_5	T_5	T_6	T_2	T_3	T_4	T_2	T_7
T_4	T_6	T_8	T_6	T_9	T_7	T_3	T_6	T_5	T_4	T_8
T_6	T_7	T_9	T_8	T_{10}	T_8	T_5	T_{10}	T_7	T_7	T_9
T_9	T_9	T_{10}	T_{11}	T_{11}	T_{10}	T_8	T_{11}	T_{10}	T_{11}	T_{11}

[a] T = Treatment from Table 6.

Table 8. Analysis of variance for individual panelists

Panelist Number		Degree of Freedom	Tenderness		Juiciness		Connective tissue	
			Mean Square	F Ratio	Mean Square	F Ratio	Mean Square	F Ratio
1	Treatment	10	17.40	8.75**	1.41	0.61	7.89	8.06**
	Session	10	1.72	0.86	0.99	0.43	1.23	1.26
	Error	33	1.99		2.32		0.98	
2	Treatment	10	4.33	4.36**	0.59	0.48	2.30	3.00**
	Session	10	0.76	0.76	1.07	0.86	0.62	0.81
	Error	32	0.99		1.24		0.77	
3	Treatment	10	7.32	5.34**	1.91	1.87	5.90	4.84**
	Session	8	0.95	0.69	0.79	0.78	1.15	0.94
	Error	26	1.37		1.02		1.22	
4	Treatment	10	8.39	2.79*	1.80	1.12	9.53	5.16**
	Session	10	2.43	0.81	1.20	0.75	2.57	1.39
	Error	34	3.00		1.60		1.84	
5	Treatment	10	7.38	3.90**	1.93	1.20	6.09	3.29**
	Session	10	0.88	0.47	0.55	0.34	0.98	0.53
	Error	32	1.89		1.61		1.85	
6	Treatment	10	4.37	4.16**	1.59	1.46	5.35	3.90**
	Session	10	0.97	0.92	1.54	1.42	1.35	0.98
	Error	32	1.05		1.09		1.37	
7	Treatment	10	6.21	4.41**	1.27	1.46	4.45	4.34**
	Session	10	1.59	1.13	1.33	1.53	1.05	0.83
	Error	33	1.41		0.87		1.26	
8	Treatment	10	8.98	6.29**	0.45	0.51	7.58	4.97**
	Session	10	1.46	1.02	2.41	2.73*	3.22	2.11
	Error	34	1.43		0.88		1.52	
9	Treatment	10	11.36	5.80**	1.89	1.29	5.37	4.99**
	Session	9	4.68	1.44	2.10	1.44	0.94	0.87
10	Treatment	10	13.99	6.49**	1.49	0.97	14.62	8.00**
	Session	10	3.27	1.52	1.01	0.66	1.74	0.95
	Error	34	2.16		1.55		1.83	

* Significant at < .05
** Significant at < .01

ıble 9. Analysis of variance for combined panel.

Source of ıriation	Degree of Freedom	Tenderness		Juiciness		Connective tissue	
		Mean Square	F-ratio	Mean Square	F-ratio	Mean Square	F-ratio
ınelist	9	4.28	2.40*	11.40	8.44**	10.14	7.14**
reatment	10	86.71	82.58**	4.75	45.7**	69.60	64.44**
ınelist x Treatment	90	1.05	0.56	1.04	0.77	1.08	0.76
rror	416	1.78		1.35		1.42	

Significant at <.05
Significant at <.01

Table 10. Estimates of measurement error.

Palatability Attribute	Standard Deviation (individual panelists)	Standard Deviation of the Mean (Average of 10 panelists scores
Tenderness	1.28	0.40
Juiciness	1.14	0.36
Connective tissue	1.36	0.51

Table 11. Correlation coefficients among Panels for three palatability attributes.

TENDERNESS

	Panel 1	Panel 2	Panel 3	Panel 4
Panel 1	1.00	.88	.93	.92
Panel 2		1.00	.90	.90
Panel 3			1.00	.94
Panel 4				1.00

JUICINESS

	Panel 1	Panel 2	Panel 3	Panel 4
Panel 1	1.00	.17	.17	.42
Panel 2		1.00	.07	.30
Panel 3			1.00	.36
Panel 4				1.00

CONNECTIVE TISSUE

	Panel 1	Panel 2	Panel 3	Panel 4
Panel 1	1.00	.86	.81	.82
Panel 2		1.00	.84	.85
Panel 3			1.00	.79
Panel 4				1.00

n = 55 longissimus steaks.